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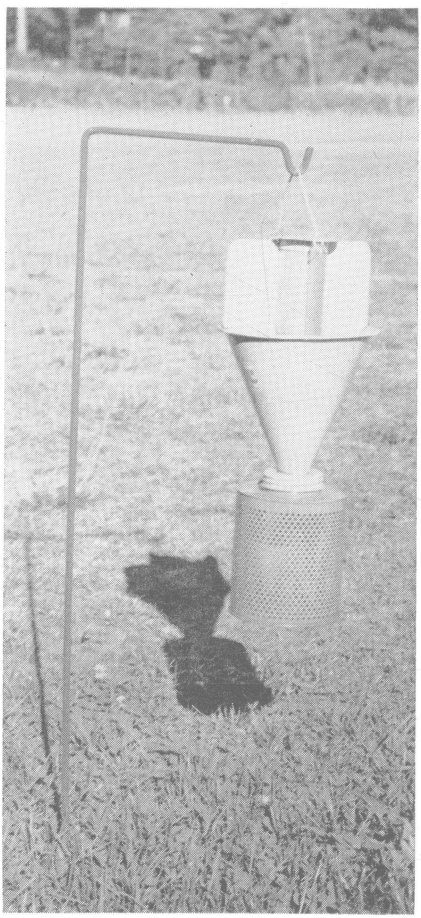

Results of Area Campaigns Against Japanese Beetles in OHIO

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SUMMARY

It may be concluded from the data presented in this paper that the acreage treated in these studies was not of sufficient size to eliminate the Japanese beetle from damaging ornamental plants within the center of the treated area. In fact, the flight behavior and natural dispersal studies indicate that the minimum area would have to be greater than 12,000 acres.

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RESULTS of AREA CAMPAIGNS AGAINST JAPANESE BEETLES in OHIO

J. B. POLIVKA

How large a section must be treated with an insecticide in order to prevent the Japanese beetle adult from damaging ornamental plants within the treated area? This question has arisen many times in the past few years and the answers given have been largely based upon opinion rather than facts. In view of this situation the author decided to review past records in an attempt to answer this question. This report is presented to show the results obtained when insecticides were applied from the air and from the ground for the control of the adult and larval stages of the Japanese beetle.

Licking County Area - Newark, Ohio

In 1946, the personnel in the State Department of Agriculture and the Cooperative Extension Service wanted to find out if it might be possible to reduce or eliminate the heavy infestation of the Japanese beetle in the Newark area which was centered on a farm on the eastern outskirts of the city. To accomplish this, an airplane was used to distribute DDT at the rate of 30 pounds of a 5 percent dust per acre over the heaviest area. A hand duster was used to apply the insecticide in a few isolated spots. In all, 100 acres were dusted.

Two treatments were applied. The first application was made on July 9 and the second on July 19 and 20. The effectiveness of the material was determined by counting the number of beetles found on smartweed, elm, and asparagus in a definite period of time. Table 1 shows the results of the beetle count before the plants were dusted and about the middle of the day on subsequent days of examination.

These data indicate that the insecticide reduced the adult population on smartweed from 17.2 beetles per minute before treatment to 9 beetles per minute approximately one half hour after application. Since elm and asparagus were not dusted until late in the evening on July 9, the first counts on these host plants were made on July 11. These data are very encouraging. However, it clearly shows that the population was not eliminated from the area.

During the period of 1945 to 1948 inclusive, several traps were

Table 1.—The Average Number of Beetles Found per Minute. Newark, Ohio. 1946.

Date examined	Host		
	Smartweed	Elm	Asparagus
July 9	17.2[1]	20.5[1]	12.0[1]
	9.0[2]	—[1]	—[1]
11	7.0	.5	1.7
13	3.0	.0	.7
15	1.0	.0	.0
17	6.8	4.0	1.3
19	2.4	2.5[4]	2.3[4]
24	3.0	.0	.0
29	.8	7.0	1.0
August 1	9.5	.0	.0
5	3.7	.0	.0

[1]Population before application.

[2]Population 30 minutes after application.

[3]Dust applied late in the evening of July 9 and no count taken on that date.

[4]Population before area was dusted the second time. Rain delayed the application. Completed July 20.

located on the farm that was dusted for the purpose of determining the adult population in the area. Table 2 shows the average yearly catch of Japanese beetles per trap and the change in population from the previous year on a percentage basis.

These data show that the adult population per trap in 1947 was much lower than it was in 1946. In checking the rainfall and temperature records during the month of July of 1946 (5.41 inches total rainfall, 72°F. average temperature), it was found that the weather was wetter than normal and it is possible that the soil was too moist

Table 2.—Average Yearly Catch of Japanese Beetles per Trap Preceding and Following DDT Dusting in 1946. Newark, Ohio.

Year	Beetles per trap	Change from previous year (%)
1945	414	
1946	403	2.7 reduction
1947	76	81.1 reduction
1948	51	32.9 reduction
1949	210	76.7 increase

for the insect's development.[1] This factor was undoubtedly accountable in part for a marked decrease in the number of beetles taken per trap. Therefore, the decrease in population in the area must have been brought about by the combined effects of heavy rainfall during the latter part of July and the application of DDT.

Since the two applications of DDT in 1946 deposited 3 pounds of the actual toxicant per acre, the beetle reduction in 1947 and 1948 was probably the result of the carry over of DDT in the soil from the 1946 application. In 1949, there was an increase in the adult population. This increase in population per trap would indicate that the DDT had little effect upon the development of the Japanese beetle within the treated area or that considerable movement of the adult into the area occurred.

In October of 1945, the grub population in the area that was treated in 1946 averaged 2.5 grubs per square foot and in October of 1946 no grubs were found. Therefore, the beetles taken in the traps in 1946 must have moved into the treated area. If this was the case, it is possible that the population in 1948 was also the result of flight of the beetle from untreated areas. However, in 1949, the population rise may have resulted from an increase of the Japanese beetle in the treated area as well as from movement of the insect into the area.

Cuyahoga County - Cleveland, Ohio

Late in the fall of 1947 several persons living in a small, newly developed section in Cleveland reported that the Japanese beetle grubs were destroying their turf. Following a cooperative agreement between the 128 property owners, the Extension Service, and the Ohio Agricultural Experiment Station, a community control program was developed. The objective of this program was to prevent the adults from damaging ornamental plants within the center of the area.

The plan of the investigation consisted of seven phases: (1) Population counts were to be taken by determining the number of grubs per unit area in the front lawn of each property in early April of 1948;

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[1]In the laboratory (Wessel, 1951), the lowest survival of eggs was found in soil that received water equivalent of one inch of rainfall per week. In the Newark area the greatest amount of rainfall was received for the month during the time the largest number of eggs were present in the soil which was during the latter part of July. Daily rainfall was as follows: July 19, 1.96 inches; July 20, .41 inches; July 21, 1.53 inches; July 22, .02 inches; and July 25, 1.17 inches. This amount of rainfall kept the soil very wet for two weeks.

(2) Front lawns of all properties were to be treated with either lead arsenate, DDT, or chlordane; (3) The property owners were to treat their back lawns with an insecticide; (4) All foliage in the area would be sprayed twice during the beetle season of 1948 with a DDT emulsifiable spray; (5) Beetle trapping would be conducted during the summer of 1948 and 1949; (6) The front lawns were to be sampled for grubs again in October of 1948; and (7) Grub population counts would be taken in the front lawns again in the fall of 1949.

GRUB POPULATION COUNTS

One grub population count was made in early April before the insecticide was applied and the second was taken one year later (May 1949). Table 3 shows the estimated population of grubs per square

Table 3.—Average Japanese Beetle Grub Population per Square Foot. Cleveland, Ohio. (1948-1949).

	Before treatment 1948	After treatment 1949	
	Front lawn	Front lawn	Back lawn
Average for area	15.3	.3	4.2
Number of lawns with an average of 60 or more grubs	4	0	0
Number of lawns with an average of 30 to 59 grubs	25	0	4
Number of lawns with an average of 15 to 29 grubs	21	0	11
Number of lawns with an average of 3 to 14 grubs	31	5	27
Number of lawns with no grubs	41	123	86

foot of turf area before the treatments were applied and one year after the treatments.

These data show that there was a high initial grub population in the area despite the fact that no grubs were found in about 1/3 of the lawns. Many of the lawns in which no grubs were found before treatment received some insecticide.

SOIL INSECTICIDE APPLICATIONS

Insecticides were applied to the front lawns during the last two weeks in April of 1948. Table 4 shows the insecticides used, the average grub population both before treatment and one year later in the front lawn, and the grub population in the back lawns.

These data show that lead arsenate applied at the rate of 250

Table 4.—Japanese Beetle Grub Population in Lawns before Treatment and One Year after the Insecticide Application. Cleveland, Ohio. (1948-1949).

Toxicant	Rate actual pounds per acre	Front lawn April 1948			Front lawn May 1949			Back lawn May 1949		
		Number of samples	Number of grubs	Grubs per sq. ft.	Number of samples	Number of grubs	Grubs per sq. ft.	Number of samples	Number of grubs	Grubs per sq. ft.
Lead arsenate	250	50	183	17.0	50	6	.4	50	63	3.8
" "	375	2	13	19.5	2	0	.0	2	1	1.5
" "	500	6	33	16.5	6	0	.0	6	12	6.0
DDT	12.5	13	48	11.1	13	4	.9	13	13	3.0
"	25.0	23	178	28.2	19	1	.1	18	38	6.3
Chlordane	12.5	2	32	48.0	2	0	.0	2	7	10.5
"	15.0	12	101	25.2	12	0	.0	11	17	4.8
"	25.0	2	16	24.0	2	0	.0	2	2	3.0

pounds per acre and the DDT treatments were not 100 percent effective at the end of the first year. The 375 and 500 pound rates of lead arsenate and all levels of chlordane were 100 percent effective. The data also indicate that several property owners either failed to apply any insecticide to their back lawns or applied them in insufficient amounts to obtain satisfactory control of the grubs.

CONTROL OF ADULTS

All foliage within the area of the experiment was sprayed on July 9 and again on July 18. A DDT emulsifiable formulation was distributed with a mist sprayer and applied at the rate of 1.5 pounds of the actual toxicant per acre.

The effectiveness of the DDT was checked in the laboratory. This was done by collecting small branches of elm and smartweed within the area that had been sprayed and exposed to natural weathering for various lengths of time. Each branch was placed in a separate cage with 10 beetles that were collected at a considerable distance from the sprayed area. Unsprayed branches of approximately the same size as the treated twigs were exposed to beetles to serve as a control. After the beetles were exposed to the twigs for two days, the number of dead and living beetles were counted in each cage. Table 5 shows the host plants collected to study the residual effectiveness of the DDT application, the number of days the branches were exposed to the weather before being collected for the test, the number of twigs used in each test, the number of beetles used in each set up, the number of beetles surviving, and the percent of control.

These data indicate that the DDT spray was fairly effective for about one day on elm and three days on smartweed after the first application. The insecticide was more effective and had a longer residual effectiveness after the second application. Despite the fact that the second application gave good control of the Japanese beetle adults, the daily trap catch throughout the season did not show a drop in the number of beetles taken immediately after either one of the insecticide applications. (Polivka, 1948). The trap catches would indicate that sufficient number of beetles moved into the area to replace those killed by the application of the DDT spray.

TRAPPING PROGRAM

In 1948, 48 traps were located in the area. One trap was placed in the yard for each four lots. Complete records were obtained for only 39 of the traps. The traps from which no record was obtained were broken early in the season or were moved to a location where

Table 5.—Shows the Residual Effectiveness of DDT in Controlling Japanese Beetle Adults. Cleveland, Ohio. 1948.

Host	Number of days after application	Number of twigs used	Number of beetles used	Number of beetles surviving	Percent reduction
Sprayed-July 9					
Elm-sprayed	1	6	60	33	35.3
Elm-unsprayed		6	60	51	
Smartweed-sprayed	1	3	31	3	89.3
Smartweed-unsprayed		3	29	29	
Elm-sprayed	3	6	57	55	1.8
Elm-unsprayed		6	58	56	
Smartweed-sprayed	3	3	29	5	82.2
Smartweed-unsprayed		3	30	28	
Elm-sprayed	5	6	59	59	.0
Elm-unsprayed		3	30	30	
Smartweed-sprayed	5	3	30	26	13.5
Smartweed-unsprayed		3	30	30	
Sprayed-July 18					
Elm-sprayed	2	6	58	1	95.5
Elm-unsprayed		3	29	11	
Smartweed-sprayed	2	3	28	0	100.0
Smartweed-unsprayed		3	28	28	
Elm-sprayed	4	6	69	31	.0
Elm-unsprayed		3	30	13	
Smartweed-sprayed	4	3	30	1	94.7
Smartweed-unsprayed		3	29	19	
Elm-sprayed	6	6	60	8	75.0
Elm-unsprayed		3	28	16	
Smartweed-sprayed	6	3	30	0	100.0
Smartweed-unsprayed		3	30	18	

they attracted few beetles. In 1949, 40 traps were used. See Table 6.

The daily and weekly records for 1948 did not show a decrease in beetle population after each of the spray applications. These results would indicate that there must have been considerable movement of the adults into the area from the surrounding sections that were not treated. The data indicate, however, that the combined insecticide program (soil and foliar applications) reduced the insect population from 1948 to 1949 by 64.1 percent. When these trapping records are compared to trapping records in nearby areas, the data indicate that the insecticide program employed on these 20 acres was not the

Table 6.—Trap Catches of Japanese Beetles for the Years of 1948 and 1949. Cleveland, Ohio.

	Year	
	1948	1949
Total number of beetles taken	140055	51553
Number of traps used	39	40
Beetles per trap	3590.6	1288.8
Percent reduction		64.1

main factor in the reduction of the adult population. The data in Table 7 show the beetle population at various locations in Cuyahoga County and the average for the county.

In comparing the figures in the last column of Table 7 with the percent reduction in the previous table, there is an indication that the insecticide treatments did have some effect upon the insect population. When the weather factors are considered, it is understandable why a reduction in population occurred throughout the county in 1949 as compared with that of 1948. Unpublished data indicate that when there is a rainfall of two inches or less during the month of July a reduction in adult population occurs the following year. In checking rainfall and temperature records for July of 1948, it was found that the total rainfall at the closest weather reporting station was .76 inches. The rainfall factor indicates that there would have been fewer beetles in the area without the application of an insecticide.

It can be concluded from the information presented above that insecticides were effective in reducing the grub population after one year but the overall treating program was not effective in reducing adult populations to a non-economic status. The data presented show also that the adult population was 64.1 percent lower in 1949 than it

Table 7.—Beetle Catch per Trap for Years of 1948 and 1949. Cleveland, Ohio.

	Beetle catch per trap		Percent reduction
	1948	1949	
Riverside Cemetery	8768	8308	5.4
Forest Hill Park	15096	12405	18.1
East Cleveland	2103	1315	37.5
Cuyahoga County	3837	2178	43.2

was in 1948, but when the rainfall factor was considered, the conclusion must be drawn that the insecticides were not completely responsible for the decrease in the population. Since the insect population was not completely eliminated within the area, it can not be assumed that the beetle catch in 1949 was due entirely to flight of the adults into the area.

Lake County Area - Mentor, Ohio

In July of 1948, the State Department of Agriculture used an airplane to dust 2850 acres in Mentor and Painesville townships in Lake County with DDT to control the Japanese beetle and to reduce its rate of spread into the nursery area to the east. A 10 percent DDT dust was applied at the rate of 15 pounds per acre.

The insecticide was applied at three different times during the beetle flight period. The first application was started on July 9 and finished on July 17. The second application was made during the period from July 19 to 28, and the third application was made during the period of July 29 to August 5.

According to the trapping data, at the end of the season, at Willowick, which is just west of the treated area, the maximum beetle flight occurred on July 20. Therefore, the first application was started about 10 days before the peak of beetle flight, the second application was started at about the peak of beetle flight, and the third about 10 days after the peak of beetle flight. However, the abnormally cold period of July 21 to 24 extended the beetle flight period into late August.

During the period of dust treatments, beetle counts were taken on several different plants in order to determine the effectiveness of the dust application. The results are shown in Table 8.

The area received 4.5 pounds of actual DDT per acre in the three applications. The data indicate that treatments were effective in keeping the beetle population at a low level on all plants except roses in location 3 W and grapes at 4 L. The data also show that the beetle population built up rapidly on all plants shortly after the third application. This increase in beetle population undoubtedly resulted from beetles which developed within the treated area and may have been supplemented from movement of beetles into the treated area from other sites.

The residual effectiveness of the dust applications was checked by placing dusted and undusted twigs in separate cages containing a

Table 8.—Numbers of Japanese Beetles on Various Plants within the Treated Area. Lake County, Ohio. 1948

Location	Plants	July								August								Sept.
		2	5	7	16	20	24	28	31	2	5	9	16	20	23	28	30	7
1 K	Asparagus	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
	Raspberry	0	0	0	0	0	2	1	0	0	0	1	17	17	18	10	3	1
	Althea						1	0	0	0	0	0	0	0	0	2	0	0
	Grapes	0	0	0	0	0	0	0	0	0	0	0	28	53	40	61	35	10
2 S	Roses	1	0	1	0	0	2	0	0	0	0	0	9	14	9	17	7	2
3 W	Roses			10		54		22	14	4	0	16	28	34	18	42	60	43
4 L	Grapes	0	1	2	31	0	0	2	0	0	0	3	7	15	6	0	7	13
	Smartweed	0	0	0	0	0	0	0	0	0	0	0	5	17	2	30	94	24
5 K	Willow									6	4	15		96	80		17	
6 C	Wild Grape									3	0	0	9	15	0[1]	0	0	1
	Tamarix									2	0	3	5	0	1	0	0	0
	Smartweed									2	0	10	53	7	1	2	6	3

[1]Area sprayed with mist sprayer on August 20.

known number of beetles. The twig collections were made every two days beginning one day after application. See Table 9.

The data indicate that the first application of DDT was not effective for more than one day. The second and third applications appear to be more effective but the results are sufficiently erratic to definitely state that the DDT applications did not effect a satisfactory control of the Japanese beetle on any of the host plants checked.

In 1948, and again in 1949, twelve traps were scattered over the treated area in order to determine the adult population within the dusted area. The same area was dusted again in 1949 with a 10 percent DDT dust applied at the rate of 15 pounds of the material per acre. Table 10 shows the number of beetles taken in the 12 traps for the years of 1948 and 1949.

These data indicate that the insecticide was not effective in killing the beetles as they emerged within the treated area or that there was considerable movement of adults into the treated area from the surrounding untreated sections.

FLIGHT BEHAVIOR OF THE JAPANESE BEETLE

The size of area that must be treated in order to eliminate the Japanese beetle from the exact center of an area may be estimated by the distance the adults fly during their life time. A basis for this estimate is indicated by the flight behavior studies conducted in the Cleveland area several years ago. (Polivka, 1949).

In 1944, an average of 2100 beetles per week were marked with a different fluorescent dust or lacquer paint for eight weeks and released from the same location in Bratenahl, Ohio. Recoveries were made by placing traps at distances of 150 to 800 feet apart throughout the Greater Cleveland area. Of the 16,517 beetles marked and released, 190 individuals were recovered in traps in an average of 14.8 days after being released. The marked beetles were taken in traps at an average distance of 1245 feet from the point of release with a maximum distance of 5400 feet.

These flight studies indicated that beetles tended to move with the wind. The data also indicated that the distance traveled by the Japanese beetle adult is largely determined by the velocity of the wind. Marked beetles were picked up at a greater distance from the point of release following a period when the wind was blowing at the rate of 3 miles or less per hour than in winds of 7 miles or more per hour.

Table 9.—Residual Effectiveness of 10 Percent DDT Dust Applied by Airplane in Controlling the Japanese Beetle. Lake County, Ohio. 1948.

Host		Number of twigs	Number of beetles	Date dusted	Date set up	Date exam.	Number of beetles		Percent reduction
							living	dead	
Elm	Tr.	3	29	7-9	7-10	7-12	17	12	41.4
"	Ck	3	30		"	"	26	4	13.3
Smartweed	Tr.	3	30	"	"	"	14	16	53.3
"	Ck	3	28		"	"	16	12	42.9
Grape	Tr.	3	30	"	"	"	19	11	36.7
"	Ck	3	30		"	"	26	4	13.3
Elm	Tr.	3	27	"	7-12	7-14	26	1	3.7
"	Ck	3	30			"	30	0	.0
Smartweed	Tr.	3	31	"	"	"	28	3	9.7
"	Ck	3	31		"	"	31	0	.0
Grape	Tr.	3	30	"	"	"	26	4	13.3
"	Ck	3	30		"	"	30	0	.0
Elm	Tr.	3	27	"	7-14	7-16	27	0	.0
"	Ck	3	30		"	"	30	0	.0
Smartweed	Tr.	3	30	"	"	"	30	0	.0
"	Ck	3	30		"	"	30	0	.0
Grape	Tr.	3	29	"	"	"	29	0	.0
"	Ck	3	30		"	"	30	0	.0
Elm	Tr.	3	26	7-19	7-20	7-22	2	24	92.3
"	Ck	3	28		"	"	0	28	100.0
Smartweed	Tr.	3	30	"	"	"	0	30	100.0
"	Ck	3	28		"	"	28	0	.0
Grape	Tr.	3	33	"	"	"	4	29	88.0
	Ck	3	22		"	"	9	13	59.1
Smartweed	Tr.	3	32	"	7-22	7-24	15	17	53.1
"	Ck	3	29		"	"	26	3	10.3
Grape	Tr.	3	29	"	"	"	10	19	62.4
"	Ck	3	35		"	"	26	9	25.7
Elm	Tr.	3	31	"	7-24	7-27	0	31	100.0
"	Ck	3	28		"	"	16	12	42.9
Smartweed	Tr.	3	29	"	"	"	10	19	65.5
"	Ck	3	31		"	"	5	26	85.1
Willow	Tr.	3	29	"	"	"	4	25	86.2
"	Ck	3	32		"	"	9	23	71.9

Table 9.—Continued—Residual Effectiveness of 10 Percent DDT Dust Applied by Airplane in Controlling the Japanese Beetle. Lake County, Ohio. 1948.

Host		Number of twigs	Number of beetles	Date dusted	Date set up	Date exam.	Number of beetles		Percent reduction
							living	dead	
Elm	Tr.	3	30	7-19	7-26	7-29	3	27	90.0
"	Ck	3	27		"	"	27	0	.0
Smartweed	Tr.	3	31	"	"	"	27	4	12.9
"	Ck	3	28		"	"	28	0	.0
Elm	Tr.	3	28	7-29	7-31	8-2	6	22	78.6
"	Ck	3	30		"	"	22	8	26.7
Smartweed	Tr.	3	30	"	"	"	0	30	100.0
"	Ck	3	30			"	15	15	50.0
Grape	Tr.	3	30	"	"	"	7	23	77.0
	Ck	3	29		"	"	8	21	72.4
Elm	Tr.	3	30	"	8-2	8-5	0	30	100.0
"	Ck	3	30		"	"	8	22	73.3
Smartweed	Tr.	3	30	"	"	"	0	30	100.0
"	Ck	3	30		"	"	6	24	80.0
Willow	Tr.	3	30	"	"	"	3	27	90.0
"	Ck	3	29		"	"	2	27	93.1
Elm	Tr.	3	29	"	8-9	8-14	3	26	89.7
"	Ck	3	28		"	"	6	22	78.6
Smartweed	Tr.	3	29	"	"	"	6	23	79.3
"	Ck	3	28		"	"	15	13	46.4
Willow	Tr.	3	30	"	"	"	4	26	86.7
"	Ck	3	32		"	"	20	12	37.5

Table 10.—Japanese Beetles Trapped in Lake County, Ohio, for the Years 1948 and 1949.

Year	Number of traps	Total beetle catch	Average Number beetles per trap
1948	12	1561	130.1
1949	12	1331	110.1

Trapping studies, conducted to determine the rate of spread of the insect in Ohio, also provide information for estimating the acreage which would require treatment.

During the period from 1943 to 1948 inclusive, an extensive trapping program was conducted in Guernsey County for the purpose of watching the rate of spread of the Japanese beetle from the infestation centered at North Salem. Traps were placed along the fringe of the known infested area and at distances of 1, 2, and 3 miles beyond the known area of infestation. The results obtained from this trapping study showed that beetles moved for only a mile in some years and as much as 2.5 miles in others.

Japanese beetle adults are strong fliers and may be expected to disperse from their origin to a distance of 1 to 2.5 miles in a single season.

DISCUSSION OF RESULTS

The information presented in this paper was taken from three different areas that were treated with an insecticide for the control of the Japanese beetle. In the first area, where 100 acres were dusted twice with DDT dust at the rate of 1.5 pounds of the actual toxicant per acre per application, beetles were found throughout the area during the treating program and the year afterwards. In the second area, 20 acres of turf, except 4 back lawns, were treated with either lead arsenate, DDT, or chlordane and all host plants were sprayed twice with an emulsifiable DDT spray. Despite this heavy insecticide application the traps took an average of 3/4 of a pint of beetles per trap the year after treatment. This number of beetles is generally considered an average catch in a fairly heavily infested area. In the third area, 2850 acres were dusted 3 times in 1948 at the rate of 1.5 pounds of the actual toxicant per acre per application and in 1949 a similar series of applications were made. In spite of this rate of insecticide application which amounted to 12 pounds of actual DDT per acre, beetles were found throughout the area during the treating program and have been found in the treated area each year since that time.

These findings are not surprising since the flight studies conducted in 1944 demonstrated that adults will fly a distance of 5400 feet and the studies of 1943 to 1948 have shown that the beetles moved as much as 2.5 miles. When this flight behavior of the Japanese beetle is considered in a community control program, it is apparent that it would be necessary to treat a minimum of at least 12,000 acres before a reduction of the adult population could be expected in the exact center of the treated area.